DELAWARE STATE MEDICAL JOURNAL

Issued Monthly Under the Supervision of the Publication Committee
Owned and Published by the Medical Society of Delaware

VOLUME 15
NUMBER 2

FEBRUARY, 1943

Per Year $2.00
Per Copy 20c

MEDICAL CONTROL OF INDUSTRIAL EXPOSURE TO TOXIC CHEMICALS

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THE FUNCTION OF THE INDUSTRIAL PHYSICIAN

The major function of the physician in industry is prevention, not diagnosis. Where there is a hazard to health from chemicals (and in these days this may be present in almost all industries), the physician must prevent not only spectacular cases of poisoning, but also less obvious conditions of depreciated health. Contrary to impressions often given by the literature of industrial toxicology, the major loss of time and efficiency (and, therefore, economic loss to both worker and employer) does not result from definite poisoning. It comes from many cases of a degree of impairment of health which may be unrecognized as to type or origin. Often these are classed by the family physician as "neuro-circulatory asthenia," "nervous indigestion" and so on. The most valuable work of the industrial physician lies in this borderline field. Thus, his total preventive function can best be expressed as "Maintenance of Good Health Under All Circumstances."

THE SCIENTIFIC BASIS OF PREVENTIVE INDUSTRIAL MEDICINE

Prevention is harder than diagnosis. It cannot be based successfully upon the type of information and laboratory tests used in diagnosis. It must be founded on a fund of practical physiological knowledge, which allows the early detection of even slight departure from the usual. Since the changes which must be noted are far less tangible than those present in frank poisoning, a program of preventive medicine must be even more systematic than one of diagnosis. It must include not only the examination of each employe on application for a job but also periodic study when at the job.

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THE PREEMPLOYMENT EXAMINATION

When he applies for employment, each worker should be given a comprehensive medical examination. The sole purpose of this examination is *selective*. By it, workers can be classified according to their physical ability to fulfill the duties of the jobs to which they are to be assigned and to withstand the health hazards, which may be involved.

The selective examination must be based on a detailed knowledge of the work done in each part of the plant. Where hazards from chemicals may exist, the examining physician must know all that he possibly can about them, and should classify them in some manner so that he may properly locate his workers. A physician who only examines, and does not make himself intimately acquainted with operations in his plant, is not an industrial physician. He is merely an examiner.

Because, in the practice of industrial preventive medicine, the medical study of the worker extends beyond the initial selective examination, that examination must contain all the procedures which may later be used in periodic checks.

PERIODIC EXAMINATION

The practice of selecting employes by a preemployment examination and then studying them only when they are sick or are discharged is futile. Even the program of annual checkup examinations, while a great advance over a mere preemployment examination, is woefully inadequate for the proper control of health in industries using chemicals. There must be a program of periodic re-examinations, varying in frequency according to the degree of health hazard in different occupations.

FUNDAMENTAL INFORMATION REQUIRED FOR SELECTIVE AND PERIODIC EXAMINATIONS

Since the purpose of both selective and periodic examinations is to prevent the worker from being injured by his work, both must be based on proper information about

the hazards of that work. In the term, "proper information," lies the key to successful preventive medicine in industry. The literature on industrial toxicology is voluminous, but suffers from important defects. It deals almost exclusively with the clinical history and pathology of pronounced cases of human poisoning or of experimental poisoning of small laboratory animals. It necessarily covers only a limited number of industrial chemicals and tends to emphasize specificities in their action. Thus it fails to give information of use in hazards due to new chemicals.

The physician in industries using chemicals must remember that any chemical can be a source of injury if used carelessly or without proper information, but that with proper information and proper care, any chemical can be manufactured and used with minimal injury to health, no matter how potentially harmful it may be.

It is usual to divide cases of chemical injury into two major classes—acute and chronic. Acute poisoning appears within a few minutes, hours, or days of exposure to a very active concentration of a toxic chemical. Chronic poisoning develops slowly during months or years of exposure to low concentrations of a toxic chemical or at least to concentrations which are not immediately highly effective.

Existing literature on industrial toxicology overemphasizes acute poisoning. This leads some to believe that unless a chemical quickly causes obvious injury or death, it is not to be feared. No conclusion could be more erroneous. The loss of time and efficiency in industry, from cases of acute poisoning is relatively insignificant if compared with losses due to undetected or unrecognized effects of prolonged exposure to such concentrations of chemicals as never cause acute poisoning.

Acute poisoning usually results from accident or carelessness. Accidents follow a breakdown of physical equipment, temporary inadequacy of personnel, or carelessness. The breakdown of physical equipment may be the result of initial faulty construction, poor maintenance, improper operation, or, again, carelessness. Construction, maintenance and operation problems lie in the field of the engineer and chemical engineer. The physician, as physician, has here no function other than diagnosis and treatment of the results of accidents.

By temporary inadequacy of personnel, we mean the failure of usually competent workers to perform their duties when this failure is definitely not due to ordinary carelessness. Accidents originating in such failure may be very serious, involving more than the defective worker, and quite frequently leading to important damage to material and equipment. We may suggest, as examples, some of the major accidents in war explosives industries. Little study has been made of this temporary inadequacy. There is good reason to suggest that it may be due sometimes to the undetected effects of chronic exposure to chemicals.

Proper information for diagnosis and treatment of acute poisoning comprises that mass of clinical knowledge used in any case of sickness. Apart from occasional specific antidotes which may hinder or prevent absorption of poisons taken orally, the principles of diagnosis and treatment are the same as for any illness. It is not absolutely necessary to know the cause of injury to find which organs are affected. A knowledge of the specific action of some chemicals may help in selecting the best (that is, the safest and most rapid) means of eliminating them from the system, and allow the physician to foresee possible complications; but the poisoned patient can be treated successfully even if the cause of his condition is not known. This is fortunate because the literature of toxicology, voluminous as it is, covers only a few of the chemicals used in industry and could never keep pace with the rate with which new ones are produced. In these days of chemotherapy one warning is in order. When treating a case of chemical poisoning, be sure that your therapy does not further injure the patient. The reasons for this warning will be apparent later.

Chronic poisoning, by definition, does not develop rapidly and, therefore, cannot be ascribed to accident. It may result from an initial defective construction of physical equipment, or from defects due to the inevi-

table forces of aging, or to improper operation. Probably, however, most chronic poisonings may be ascribed to the practical impossibility of preventing all contact of worker with chemical. This is particularly the case when a toxic substance can be absorbed through the skin, a route of exposure which is much more common than is usually suspected.

Since, in chronic poisoning, months or years may be involved in slow development of injury before the victim is recognized clinically as sick, there may be no definite point at which the physician can be advised to apply his diagnostic skill. The major function of the physician here is prevention, not diagnosis, and, therefore, it is important that his proper information is such as to allow of detecting the least departure of the worker from his normal physical condition.

The literature of industrial toxicology is specifically defective in adequate information for a program for prevention of chronic poisoning. There has been a lack of opportunity for close, continuous observation of workers. The detection of slight departures from normal health and their trend cannot be made by the usual laboratory tests or procedures of pathology. Controlled experiments on small animals are of little value unless a detailed study of physiology on the intact animal is carried out.

Close medical observation of workers exposed to chemicals has been difficult because the methods used must conform to certain rigid criteria. Industry aims at making goods, not medical records. Any examination of workers requires absence from the job. The type of examination used must, therefore, be simple, not involving much loss of time or the use of techniques such as blood sampling, which might reduce the efficiency of the worker, or lead to personal objections. To give the maximum information with least time loss, data must be obtained as measurements not opinions, and so recorded as to be susceptible to statistical analysis. In the interest of scientific economy, the procedure of examination should be applicable to at least the majority of chemical exposures now existing, and to at least a majority of those which might result from introduction of new substances into industry. The changes from normal which the examination measures and records must, therefore, not be specific, but rather those produced by a majority of chemicals in concentrations having a low degree of physiological activity.

No success has attended efforts to base a general picture of physiological action upon gross or minor details of chemical structure. The numerical values of many physical properties can be calculated arithmetically from indices for active chemical groups or nuclei. Therefore, such physical properties are also useless in formulating a general picture.

In view of the special requirements of medical examinations used in control of industrial exposure to toxic chemicals, and in the absence of a basis for a general theory derived from chemical structure or physical properties, it is best to discard all considerations of such structure and properties and to concentrate attention upon the first response of humans or experimental animals when foreign substances are absorbed by any route, and especially through the respiratory and alimentary tracts or through the skin.

THE EARLY EFFECTS OF ABSORPTION OF TOXIC CHEMICALS

Nearly five years of study of animals and men exposed to a wide variety of toxic chemicals has enabled us to set up a relatively simple program for prevention of ill health. It is a program of medical control which is not time-consuming, and requires no complicated apparatus. It applies to large and small plants and, indeed, is adapted most easily to small plants. It can be used to study exposures to chemicals of known toxicity and to detect and follow the activity of new chemicals. The details of this scheme and results of the application are described below.

The earliest detectable action of toxic chemicals which, when absorbed into the body by any route, have a systemic, as opposed to a purely local effect, is not specific. It does not depend, except in intensity and rate of onset, upon the chemical structure or obvious physical properties of the compound involved. This early action is due to changes in the metabolism of individual tissue cells and can be described in crude terms as interference with the oxidation-reduction processes in those

cells. Any agent which interferes with these same processes will lead to the same initial results. Thus, disease, malnutrition, unnecessary exertion, or exposure to extremes of climate, may act in the same way as absorption of toxic chemicals.

Fig 1 shows diagrammatically the trend of events during exposure to chemicals. The two regions of the chart may not be clearly defined in cases of acute poisoning, but careful study of animals under controlled conditions, as well as many workers continuously exposed to a wide variety of substances, has shown the existence of each stage in the "Range of Efficient Preventive Medicine." Each of these changes is reversible. Its early detection affords an opportunity to stop progress toward the region of definite poisoning (range of diagnosis and pathology). An effective program of preventive medicine must, therefore, be based on the recognition and measurement of one or more of these early stages.

The early physiological action of foreign chemicals leads to a rather simple group of symptoms and signs. The symptoms include:

Unusual fatigue or lassitude
Headache
Dizziness
Gastro-enteric disturbances (nausea, loss of appetite, fullness of the stomach, frequent eructations, uneasiness or pain in the epigastrium)
Palpitation.

All are not present at the same time. Some may never be noted in a given case. Unusual fatigue or lassitude and gastro-enteric disturbance are the most common.

Later in the history of exposure there may be increased intensity or frequency of these symptoms, or others may appear, such as pain in the precordium, tingling or pain in the extremities, pain in the neck, and dyspnea on slight exertion.

Symptoms are more or less matters of opinion. No two workers describe the same

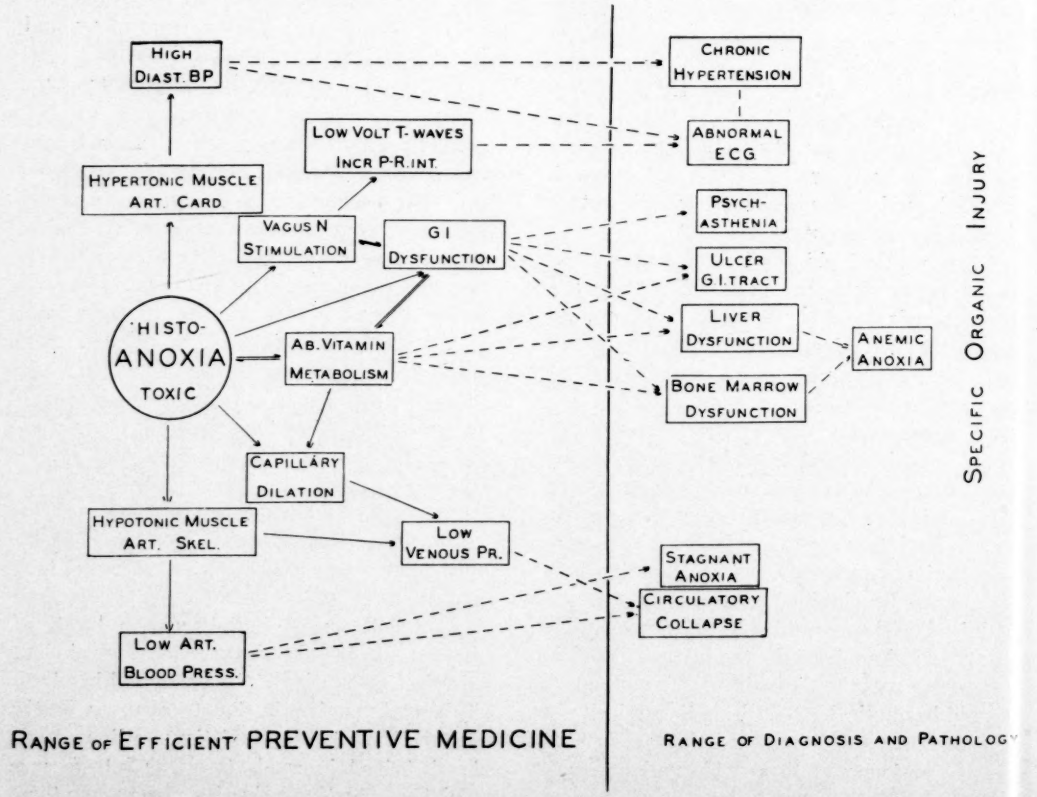

FIG. 1—Diagram showing early stages of physiological action of toxic chemicals and relationship of these early stages to chemical poisoning.

feeling in the same way. No two can give the examiner the same impression of the intensity of feeling. Further, many factors affect the degree of frankness of a worker in describing his symptoms. Symptoms should be entered on examination records, but since they cannot be expressed numerically, they are of minor value in a practical program of preventive medicine.

The signs of the early action of toxic chemicals are also limited and most require special equipment for detection. Fortunately one sign is easily measured. This is a change of blood pressure from the usual level. At first the change may be slight, but later it is so great as to give blood pressure readings which are far from the usual.

Much clinical information on blood pressure comes from the study of people who are obviously sick or from isolated examinations of applicants for life insurance policies. The results of such studies are misleading. They suggest a great variability of pressure which we have not found in frequent routine examinations of workers. Many records, obtained from hundreds of workers by examinations made as often as twice a month for five years, show that the blood pressure of a given individual remains within rather narrow limits so long as he is not affected by such factors as disease, malnutrition or toxic chemicals. The usual clinical studies of blood pressure show a general upward trend of values with age, and it is implied that chronological age alone is a determining factor. But the term, "age," holds the possibility of action of such important agents as disease, change in economic status with resultant psychic effects, change in nutrition, etc. Our accumulated data on blood pressure does not indicate that age, per se, plays a vitally important part in determining the pressure level. It is certainly subordinate to disease, malnutrition and exposure to chemicals.

Early exposure to low concentrations of chemicals just adequate to have physiological action tends to cause a rise in diastolic blood pressure. Special studies indicate that this is the result of a stimulation which increases the tonus of the muscle of the arterial walls and that property which corresponds to tonus in the heart muscle itself. With continued low grade exposure, the rise in diastolic blood pressure may go on until definitely abnormal levels are reached, and these may become fixed.

With the rise of diastolic pressure there is not, at first, an appreciable change in systolic pressure. Therefore, pulse pressure gradually diminishes, and may reach abnormally low values.

When the diastolic blood pressure has risen and become fixed at abnormal levels, the systolic pressure often begins to rise and eventually both systolic and diastolic hypertension are attained and may persist. But abnormally high systolic pressure is definitely not one of the signs of early exposure to toxic chemicals.

Higher concentrations of the same chemical act as a depressant and lead to a fall in systolic and diastolic blood pressure. These two factors may not fall at the same rate so that pulse pressure may change. Eventually, both systolic and diastolic pressure attain abnormally low levels. Usually the systolic pressure is the first to become abnormal. One may often see cases in which all three blood pressure components—systolic, pulse and diastolic pressures—are very low. This depressant phase of the action of chemicals can

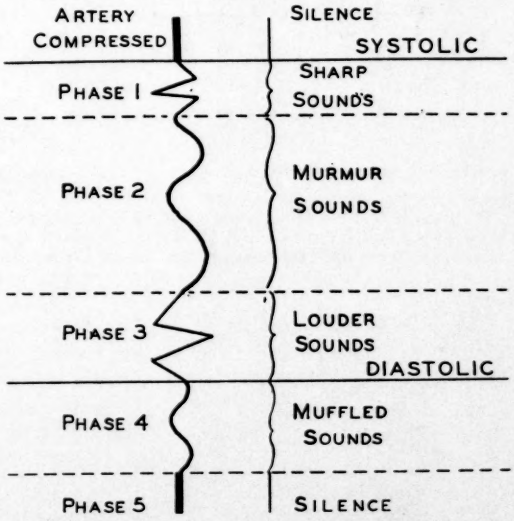

Diagram of sound phases in measurement of blood pressure, from Robert Southby, Medical Journal of Australia, 2: 569, 1935.

lead to circulatory collapse, as a result of marked diminution in muscle tonus and a failure of the venous blood to return in adequate quantity to the right side of the heart,

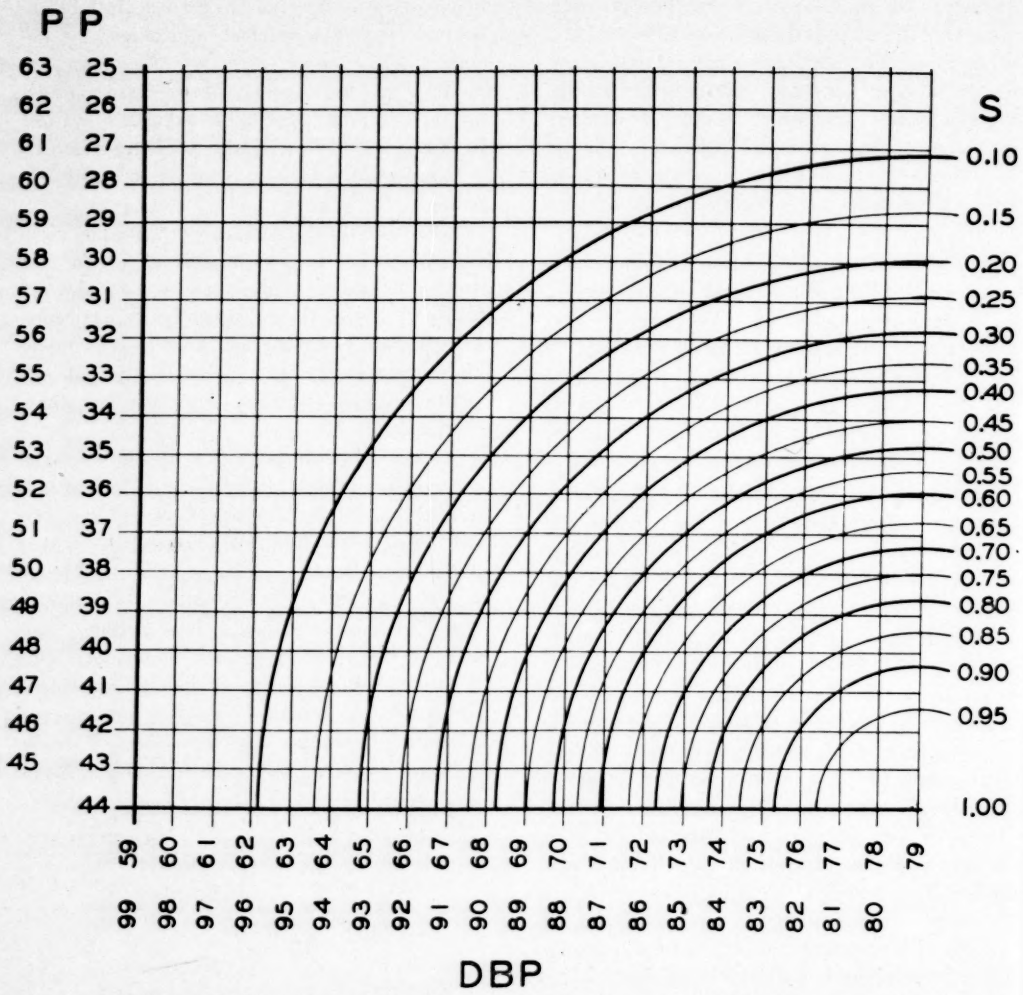

FIG. 2—Chart for calculation of score for diastolic and pulse pressure readings. Read the diastolic blood pressure on the horizontal axis and the pulse pressure on the verticle axis. Find the intersection of these two and estimate the score from the nearest quadrant to this intersection, reading the scores at the right-hand end of the end of the quadrant under the letter S.

thus decreasing the ability of the circulatory system to compensate for changes in posture.

These changes in blood pressure, even the most drastic, appear before any tissue is irreversibly injured. They are purely functional in origin, but if the exposure which causes them is allowed to persist definite organic injury may follow—the typical textbook picture of poisoning.

MEASUREMENT OF BLOOD PRESSURE

Blood pressure measurements can be used in a program of preventive medicine only if they are properly made and recorded, and are studied by a procedure which allows one to follow trends.

In our work we find it best to measure the blood pressure with the patient sitting, employing the technic recommended by the Joint Committee of the American Heart Association and the Cardiac Society of Great Britain and Ireland, (1) with certain additions mentioned below. Before any measurement is made, the patient must have been sitting quietly for at least five minutes, without smoking. This allows the circulatory system to become stable after the exertion necessary

in going from the place of work to the plant physician's office.

We measure the pressure on both arms. In changing the sphygmomanometer cuff from one arm to the other, the worker should not get up, or move rapidly to assume a comfortable position. He should move slowly; otherwise, he destroys the stability produced by the five minutes of rest.

We measure and record routinely the diastolic pressure on both arms, at 4th and 5th phases (i. e., change of sound and disappearance of sound), and all pressure measurements are entered on the record at the actual level shown by the manometer (usually to each 2 mm.)—not at the nearest 5 to 10 mm. There is no gesture more useless, even for "the record," than a measurement of blood pressure recorded to the nearest 10 mm.

The measurement on both arms and at both readings of diastolic pressure is not ordinary clinical practice, but in preventive medicine in industry we find it valuable, since experience shows that one of the earliest signs of physiological action of chemicals may be an abnormal difference between systolic or diastolic pressures of the two arms, or between the two levels of diastolic pressure on one or both arms.

Useful Levels of Blood Pressure

In repeated surveys of medical records, we find that the occurrence of readings *outside* the following arbitrary "normal" limits in individuals selected by preemployment examination give indications of chemical exposure or other factors mentioned later. These levels are also useful in quick estimates of the significance of the preemployment examination, itself.

"Normal" Pressure Limits

Systolic Pressure	100 - 149 mm.
Diastolic	65 - 89 mm.
Pulse Pressure	30 - 58 mm.
Difference between two arms:	
Systolic Pressure	0 - 20 mm.
Diastolic Pressure	0 - 10 mm.
Difference between 4th and fifth phase diastolic pressure, either arm	0 - 10 mm.

Scores of Blood Pressure

The use of such arbitrary levels, however, gives little information on trends and less on the actual condition of the circulation as a whole. For this reason we have developed a system which gives a score to each blood pressure reading according to the distance of pulse pressure and diastolic pressure from the respective means derived from a study of many records.

Mathematically, it is expressed by the formula:

$$\ln S = -0.00339\ (x^2 + y^2)$$

where

- S = Score
- $\ln S$ = Logarithm of S to the base 10.
- x = Deviation of diastolic blood pressure from an established mean of 79 mm.
- y = Deviation of the pulse pressure from an established mean of 44 mm.

The nomograph (Fig. 2) allows of easy reading of the score for any level of diastolic and pulse pressure.

In this system, the established mean for diastolic pressure is 79 mm. and that for pulse pressure is 44 mm. Readings at these exact measurements are given values of 1.0. Other readings are given values less than 1.0 decreasing the further we pass away from the means. Thus, a diastolic pressure of 89 mm. and one of 69 mm. have the same score, and a pulse pressure of 35 mm. has the same score as one of 53 mm. Finally, we combine these two components into a complete score which is the product of individual pulse pressure and diastolic pressure scores. This is done because these two factors completely define any blood pressure measurement. But while both diastolic pressure and pulse pressure must have real values during life, there is no simple correlation between their values. Therefore, they can be considered as independent events, occurring simultaneously. Since the mathematical derivation of the individual score for each component is, to some extent, a measure of its probability of occurrence, the final score used is the product of the individual scores.

In using this scoring system, we calculate the score from the arithmetic average of readings for the two arms. We use the measurement of diastolic pressure at the 4th phase (change of sound) in calculating the

score, except in special cases in which a chemical can easily produce circulatory collapse (e. g., nitrites). In these special cases we use the 5th phase reading.

After much study of this scoring system we have come to consider scores between 0.11 and 0.20 as of doubtful normality, and scores of 0.10 or less as definitely abnormal.

It has been pointed out that the selective examination given a worker when he applies for employment should contain the criteria to be used in periodic checks to be made during employment. Therefore, the comprehensive selective examination should contain the described blood pressure measurements, and when the worker is to be exposed to a toxic chemical his blood pressure score should be greater than 0.10 (preferably 0.20 or higher). In applying this criterion, however, one situation must be remembered. When a worker applies for a job he is already under psychic pressure. He is obviously needing a job or he would not bother to apply. The extent of his need may be great. Often, he has not received a medical examination before—or at least not so comprehensive an examination as is given by many industrial medical divisions. To him the procedures required may appear almost as a personal affront and so still further increase his apprehension. Under such conditions many people show an unusually high systolic pressure with a normal diastolic pressure. As a result, the pulse pressure may be an index of psychic instability. It can be disregarded unless the worker is to be employed in a job requiring great stability, or exposure to a chemical affecting the central nervous system. But the recurrence of an abnormal score due solely to high pulse pressure (i. e., with normal diastolic pressure) during periodic examinations should be a matter for careful inquiry. (A study of the reasons for occurrence of such abnormal scores among work groups can be interesting. Thus, it has been found that a new foreman, in his efforts to increase or improve production—and, incidentally, justify his promotion—can so disturb young workers that a whole "flock" of abnormal scores, due solely to psychic causes, may result. The present war with its accompanying prospects of being drafted into the Army, has produced similar results.)

REGISTRATION OF BLOOD PRESSURE SCORE AND ANALYSIS OF RESULTS

No program of periodic examination is of any value unless its results are properly registered and frequently studied. Study is most efficient if it is made on a statistical basis. The best form of registration is one in which pertinent data is collected together and so can be analyzed easily. The less pertinent data can be obtained when necessary by reference to the original examination record.

For ordinary purposes the pertinent data includes names of workers in a given group, the dates of examination (by months, usually), and the results of blood pressure scoring. Fig. 3 gives a facsimile page of a group register, the data employed in analysis and, at the bottom, summarized results of the analysis. The page illustrated contains headings for the groups, space for names of individuals, and opposite the latter, columns for entry of results by months (or any other convenient time unit). Each of these columns is divided into one large and two smaller columns. The large column is for entry of blood pressure scores as normal, N; or doubtful, D (i. e., 0.20 to 0.11); or abnormal, A (i. e., 0.10 or less). The narrow column headed, T, is for the total of abnormal and all examinations, entered as the fraction.

$$\frac{\text{N. Abnormal}}{\text{Total}}$$

obtained in the time interval of study (e. g., one month). The column marked "C" is for the cumulative total of abnormal and all examinations obtained by adding the total for the particular month (or other time interval) under study to the total of all preceding examinations since the group study was commenced. This cumulative total is also entered as a fraction. The meaning of the summary portion of the page will be given later.

In describing the purpose of the initial selective medical examination, it was pointed out that *the plant physician should know his plant and be able to classify the various health hazards so that he can properly allocate workers.* An effective preventive medical program requests that he make a proper survey of his plant. Such a survey can be based upon blood pressure readings and

YEAR

OCCUPATION

NAME	JAN			FEB			MAR			APR			MAY			JUNE		
		T	C		T	C		T	C		T	C		T	C		T	C
W. J.	N A A*	2/3	2/3	A N *	1/2	2/5	N N N*	1/3	2/6	N N *	2/5	4/8						
J. B.	N N	0/2	0/2	N N	0/2	0/4	N A	0/2	0/4	N A	1/2	1/10						
W. W.	N A	1/2	1/2	N N	0/2	1/4	N N N	0/3	1/2	N N	2/5	4/9						
B. G.	N N N	0/3	0/3	N N A	1/3	1/6	A N N	1/3	2/7	N N A*	1/3	3/10						
H. B.	N N	0/2	0/2	N N	0/2	0/4	N	0/1	0/5	N N	2/5	4/9						
B. J.	N N	0/2	0/2	N A	1/2	1/4	N N	2/5	0/5	N	0/1	1/7						
B. W.	A N	1/2	1/2	N N	0/2	1/4	N N	0/2	1/5	N A	1/2	2/9						
G. C.	N N	0/2	0/2	N N	0/2	0/4	A A *	2/5	2/6	N A N*	1/3	2/9						
Z. C.				N N	0/2	0/4	N N A	1/3	1/6	N N	0/2	1/7						
T. & O.	N N N	0/3	0/3	N A A *	1/3	2/6	N N N	0/3	2/7	N A A*	2/3	3/10						
J. G.	N N	0/2	0/2	N	0/1	0/3	N N	0/2	0/5	N N	0/2	0/7						
W. F.	N N	0/2	0/2	N N	0/2	0/4	N N.	0/2	0/6	N N	0/2	0/8						
A. F.	A	1/1	1/1	A N N*	1/3	2/7	N N N	0/3	2/9	N A *	1/2	3/11						
G. R.	N A	1/2	1/2	N N	1/2	2/4	A A *	2/4	2/8	N N *	2/5	5/13						
H. G.	N N	0/2	0/2	N N	0/2	0/4	N N	0/2	0/8	N A N	1/3	1/9						
G. V.	N A	1/2	1/2	A N N*	1/3	2/7	N N N	0/3	2/8	N N	0/2	2/10						
C. H.	N A A*	2/3	2/3	N A N*	1/3	3/10	N A N*	1/3	3/11	N N N*	0/3	3/12						
W. H.	N N	0/2	0/2	N	0/1	0/3	N N	0/2	0/6	N	0/1	0/8						
C. J.	N N	0/2	0/2	N N	0/2	0/4	N N	0/2	0/6	N A	1/2	1/9						
J. M.							N A A*	2/3	2/9	N A N*	1/3	2/12						
J. F.	N	0/1	0/1	N A N	1/3	1/4	N N	0/2	1/8	N	0/1	1/10						
A. R.	N A	1/2	1/2	N N	0/2	1/3	N N *	1/2	2/10	N N	0/2	2/12						
H. P.	N N	0/2	0/2	N N	0/2	0/4	N	0/1	0/5	N N	1/2	0/7						
C. A.	N N	0/2	0/2	N N	0/2	0/4	N	0/1	0/5	N N	0/2	0/7						
L. J.	N N N	0/3	0/3	N N	0/2	0/5	N A N	1/3	1/8	N A	1/2	1/9						
B. K.							N N	0/2	0/8	N A N	1/3	1/12						
TOTAL MEN	23			24			26			26								
CHR. AB. MEN	2			5			6			8								
EX. ALL GP.		10/46	12/69		9/52	19/101		17/69	31/160		17/67	48/227						
EX. N-C. GP.		6/23	6/23		3/26	7/76		4/26	12/52		6/25	17/138						
RATIOS OBS/EXP. AB																		
C. MEN	0.67			1.67			1.50			2.00								
ALL EX.		1.67	1.67		1.50	1.73		1.71	1.94		1.71	2.45						
EX. N-C. GP.		1.00	1.00		0.66	0.77		0.67	1.25		1.20	1.21						

FIG. 3—Form of group registration of blood pressure examination results for statistical analysis.

scores. Except when the plant is new, it need not be a mass survey. It can be made up of smaller surveys each of an occupation area. A fair idea of the general spread of hazard among occupations can be obtained from annual medical examinations, scoring the blood pressure measurements, provided that too many changes in equipment and processes have not occurred since those examinations were made.

FREQUENCY OF OCCURRENCE OF ABNORMAL EXAMINATIONS

The survey of degrees of hazard requires a yardstick of the frequency of occurrence of abnormal blood pressure scores.

Experience has shown that

(a) a worker selected initially as having a blood pressure score above 0.10, when subsequently examined a very large number of times, will not show a score of 0.10 or less as a result of chance alone (i. e., as a result of unexplainable causes) in more than 6% of all his examinations;

(b) a very large group of workers, initially selected as having normal blood pressure scores, when again examined once will not show 0.10 or less in more than 6% of all scores as a result of chance alone; and

(c) in a very large number of re-examinations on more than one worker, each worker being selected initially as having a score above 0.10, chance alone will not give more than 6% of all examinations with scores of 0.10 or less.

Since it is impossible at any given time to make a "very large number" of examinations in the statistical sense, the 6% figure must not be considered as applying to all groups of examinations. One must, in practice, use the mathematics of random sampling, arguing as follows:

Suppose a large bowl were to contain one million balls, all of one size but not thoroughly mixed. Six per cent of these balls (60,000) are black and the rest white. If, with a scoop, a random sample of 10,000 balls were taken out and found to contain 900 black balls, one should not reach the erroneous conclusion that 9% of all the million balls were black. If the random sample contained only 50 balls, it is quite possible that 6 of these are black, but one must not conclude that 12% of all balls in the bowl are black. (This is a common error in conclusions drawn from so-called statistics of clinical cases, when the incidence of deaths or cures is expressed as percentage.) It is possible to calculate the maximum number of black balls to be expected in a random sample of any size. The smaller the sample the more this maximum will depart from the overall 6%.

In using the 6% yardstick to study the frequency of occurrence of blood pressure scores of 0.10 or less in groups of examinations, we take into account the fact that any ordinary group of examinations is not statistically "very large," and use a figure for the maximum number of abnormal examinations expected by chance alone in a group of the size under study. Table 1 gives values to the nearest whole number for this maximum expected number of abnormals, calculated from the formula

$$Y = 0.06\ N + 2\sqrt{pqN}$$

in which

p = 0.94 (the probability of occurrence of normal examinations in a large group).

q = 0.06 (the probability of occurrence of abnormal examinations in a large population).

N = the number of examinations in the group.

To save space the group sizes are entered to the nearest 5. Thus, the expected number of abnormals for a group of 28 to 32 would be read as for a group of 30. For a group of 27 it would be read as for 25 and for a group of 33, read as for 35.

ABNORMALITIES INDEX *R*.

A useful index is obtained by calculating the ratio

$$\frac{\text{OBSERVED NUMBER OF ABNORMAL SCORES}}{\text{MAXIMUM EXPECTED NUMBER}}$$

for any given examination group. This we prefer to term the "abnormality index" and give the symbol "R".

Normally, this index should not exceed a value of 1.0. When it is greater than 1.0, the group under study contains too many abnor-

mal blood pressure scores. This is evidence, in our survey, of industrial exposure to toxic chemicals (or an unusual epidemic of disease, results of mass celebrations, or widespread malnutrition).

THE PLANT SURVEY

To make the preliminary plant survey, collect the most recent examinations, one for each worker. Score the blood pressure readings and then break down the results into plant areas and occupation groups. The type of results obtained is shown in Table 2. In this table, the various items are given initials as follows:

S = total number of examinations in group studied

A = number with blood pressure scores 0.10 or less

B = maximum number of abnormals expected by chance alone in group of size S (Table 1)

TABLE 1

Total Exams.	0 Max. Ab.	5 Expected	Total Exams.	0 Max. Ab.	5 Expected	Total Exams.	0 Max. Ab.	5 Expected
600	47	48	800	61	62	1000	75	75
10	48	49	10	62	62	10	76	76
20	49	49	20	63	63	20	76	77
30	50	50	30	63	64	30	77	77
40	50	51	40	64	65	40	78	78
50	51	51	50	65	65	50	78	79
60	52	52	60	66	66	60	79	79
70	52	53	70	66	67	70	80	80
80	53	54	80	67	67	80	80	81
90	54	54	90	68	68	90	81	81
700	55	55	900	68	69	1100	82	82
10	55	56	10	69	69	10	82	83
20	56	56	20	70	70	20	83	83
30	57	57	30	70	71	30	84	84
40	57	58	40	71	71	40	84	85
50	58	58	50	72	72	50	85	85
60	59	59	60	72	73	60	86	86
70	59	60	70	73	73	70	86	87
80	60	60	80	74	74	80	87	87
90	61	61	90	74	75	90	88	88
						1200	88	....

To obtain plant or group score:

Count (A) Total number of examinations;

(B) Number of examinations with Pulse Pressure-Diastolic Pressure Score 0.10 or less;

Divide (B) by value of Max. Ab. Expected, given in table.

Score above 1.00 indicates too many abnormal examinations.

TABLE 1

Total Exams.	0 Max. Ab.	5 Expected	Total Exams.	0 Max. Ab.	5 Expected	Total Exams.	0 Max. Ab.	5 Expected
1	1	1	200	19	19	400	33	34
10	2	3	10	19	20	10	34	34
20	3	4	20	20	21	20	35	35
30	4	5	30	21	21	30	36	36
40	5	6	40	22	22	40	36	37
50	6	7	50	22	23	50	37	37
60	7	8	60	23	24	60	38	38
70	8	9	70	24	24	70	38	39
80	9	9	80	25	25	80	39	39
90	10	10	90	25	26	90	40	40
100	11	11	300	26	26	500	40	41
10	12	12	10	27	27	10	41	42
20	12	13	20	28	28	20	42	42
30	13	14	30	28	29	30	43	43
40	14	14	40	29	29	40	43	44
50	15	15	50	30	30	50	44	44
60	16	16	60	30	31	60	45	45
70	16	17	70	31	32	70	45	46
80	17	17	80	32	32	80	46	46
90	18	18	90	33	33	90	47	47
						600	47	....

TABLE 2

RESULTS OF PLANT SURVEY

Whole Plant—Total Examinations S–500
Observed No. Abnormal.... A–49
Expected B–40
Ratio ..... $\frac{A}{B}$–1.225*

Area 1		Area 2		Area 3		Area 4	
S	125	S	200	S	75	S	100
A	15	A	12	A	5	A	17
B	13	B	19	B	9	B	11
R	1.15*	R	0.63	R	0.56	R	1.56*
Occupation		Occupation		Occupation		Occupation	
(a) S	55	(a) S	75	(a) S	75	(a) S	82
A	6	A	2	A	5	A	12
B	7	B	9	B	9	B	19
R	0.86	R	0.56	R	0.56	R	1.33*
(b) S	30	(b) S	35			(b) S	18
A	5	A	3			A	5
B	4	B	5			B	3
R	1.25*	R	0.60			R	1.63*
(c) S	40	(c) S	50				
A	4	A	6				
B	5	B	6				
R	0.80	R	1.00 (?)				
		(d) S	40				
		A	1				
		B	5				
		R	0.20				

R = $\frac{A}{B}$ = abnormality index

This hypothetical survey shows too many abnormal examinations for

(1) the plant as a whole;
(2) areas 1 and 4; and
(3) occupations 1b, 4a and 4b.

Occupation 2c gives an abnormality ratio of 1.0. It is apparently on the borderline of abnormality. Its true position might be found

by making another examination on each of this group and adding the results to the examinations used in the survey.

For allocation of new workers in this plant by the selective employment examinations, the order of increasing hazard by areas would be 3, 2, 1, 4; and by occupations, 2d, 2a, 3a, 2b, 1c, 2c, 1b, 4a, 4b. Only men with a perfectly normal selective examination including a blood pressure score greater than 0.10 and preferably greater than 0.20 should be allocated to occupations in which the abnormality index is above 1.0.

ANALYSIS OF RESULTS OF PERIODIC EXAMINATIONS

Workers in occupations offering a hazard to health from chemicals should be examined frequently. The time allowed to elapse between examinations will be conditioned by the speed at which the exposure produces physiological changes and by the convenience of the production department. The degree of protection afforded by ventilation, protective masks, clothing, etc., in relation to the toxicity of the compound, and the mode of its absorption must be taken into account. When absorption is mainly through the skin —and this is much more frequent than is generally supposed—it is considerably more difficult to protect workers than when absorption is only through the respiratory tract. In any case, for hazardous jobs, the periodic examinations should be made preferably at intervals of 2 to 3 weeks and should certainly not be more than a month apart. For jobs not hazardous, three, six, or even twelve months may elapse between periodic examinations unless changes in production methods introduce new chemicals. In such a case, a survey should be made as soon as the change occurs and repeated about 3 weeks later.

The program of periodic examinations should not be so rigid that any given worker is always examined on the same day of the week. Our general experience indicates that the incidence of abnormal scores is highest on the first day and the last day of the work week, (usually Monday and Friday). Examination of workers on these days gives the best index of the situation. Obviously, however, it is impractical in a large program to confine examinations to two days. Therefore, as a compromise, days of examination should be so arranged that over a period of months, each worker is studied at least once on each day of his work week.

From these periodic examinations, answers to the following questions may be obtained:

(a) Does the group under study show too many abnormal examinations?

(b) Is this condition persisting?

(c) Is this due to a few men who repeatedly show abnormal blood pressure scores, or to the group as a whole? The procedure in answering these questions is, in general, the same as that used for the general plant survey. It is as follows:

(1) Record the results of examinations in the register shown in Fig. 3.

(2) At convenient intervals; e. g., one month, count for the occupation group the total examinations and the number with abnormal scores as shown under column T; and using Table 1, find the value of R (ratio

$$\frac{\text{Observed}}{\text{Expected}}$$

number of abnormal scores for the group). This answers question (a).

(3) Using the group total of data entered under Column C (cumulative totals), again calculate R. This cumulative total is important. While it is very convenient to divide study periods into units such as months, it must be remembered that the physical condition of neither worker nor plant is stable. The situation in one given month does not depend only upon what happens between 12:01 A. M. on the first day of the month and 12:00 midnight on the last day. It depends also on what has happened in preceding days, weeks and months. This is an important point in preventive industrial medicine. The weakest link in our chain of information lies in our past inability to assess the development of effects of chronic exposure. The cumulative method of studying blood pressure scores gives great assistance in filling this gap in our knowledge.

If, by the cumulative method a given group continues to give a value of R above 1.0, question (c) is important. The answer to this is obtained by the following steps:

(4) It has been pointed out that a worker, selected by an examination which requires a normal blood pressure score, when subsequently examined a very large number of times, should not show a score of 0.10 or less by chance alone in more than 6% of all his examinations. As in the case of groups, a statistically "very large" number of examinations is not obtainable. Therefore, again, one must employ the mathematics of random sampling and calculate the maximum expected number of abnormal examinations in the actual number of examinations made on the individual. Table 1 could be used, but greater accuracy is useful here. The maximum numbers of abnormal examinations expected to occur by chance alone in groups of various sizes are shown in Table 3.

Count the number of men who have been examined more than once in the period of study. (A man examined once only obviously cannot have more than his allowed number of abnormal scores.) Find the number of these who have shown more than the allowable number of blood pressure scores of 0.10 or less (Table 3). Using Table 1, find for the group of men examined more than once, the expected number of abnormal men and calculate R.

Example. In a group of 40 men, 35 were examined more than once in a period of study. Of these, six showed more than the allowed number of abnormal blood pressure scores. From Table 1, there should be no more than 5 abnormals in a group of 35 men. Hence,

$$R = \frac{6}{5} = 1.20.$$

Men who show more than their allowable number of abnormal scores we term, "chronically abnormal," and we mark an asterisk on the register page in the month in which, by the cumulative totals, they reach this stage. So long as their cumulative totals show too many abnormals, the asterisk is continued. When, by a period free from abnormal examinations, they fall again into a normal group, the asterisk is omitted.

(5) Deduct the number of examinations and of abnormal examinations given by the chronics from the totals for the whole group. This gives the number of examinations and abnormal examinations for the non-chronic group, and R can then be calculated for this group.

In the summary at the bottom of Fig. 3, the abbreviations are as follows:

Chr. Ab. Men—the number of men who show more than their allowed number of abnormal blood pressure scores (0.1 or lower).

Ex. All Gp.—Examinations for whole occupation group entered as the fraction,

$$\frac{\text{abnormal examinations}}{\text{total examinations}}$$

TABLE 3

To Find Maximum Expected Number of Abnormal Examinations Given by an Individual

Total Examinations	Maximum Expected Number with Score 0.1 or less
1 - 6	1
7 - 14	2
15 - 23	3
24 - 31	4
32 - 41	5
42 - 51	6
52 - 62	7
63 - 73	8

Ex. N. C. Gp.—Abnormal and total examinations for the nonchronic group —obtained as given in Step (5) above.

Ratio - C. Men— $\frac{\text{Number chronic men}}{\text{Expected number of chronics}}$ as explained in Step (4).

All Ex.—Ratio $\frac{\text{Observed abnormal exami-}}{\text{Expected}}$ nations for whole group.

Ex. N. C. Gp.—Ratio $\frac{\text{Observed abnormal ex-}}{\text{Expected}}$ aminations for nonchronic group.

As in the general plant survey, a ratio with value above 1.0 suggests an occupational exposure. By the breakdown described in steps 4 and 5, it can be found whether the group ratio is due to

(1) a few chronics,
(2) to too many chronics, or
(3) to a general occurrence of abnormal examinations throughout the group.

If R for chronic men is below 1.0, then it is probable that individual factors cause some men to be chronic. If R for chronic men is greater than 1.0, it is extremely probable that exposure to a chemical is producing a chronic condition of abnormal circulation. If R for the whole group and for the nonchronic group is above 1.0, the exposure appears to be general in the group. (In such a case, R for chronics may be above or below 1.0)

THE DEVELOPMENT OF ABNORMAL SCORES

Before discussing the use of results of the analysis described above, we will consider the development of abnormal blood pressure scores as shown by a study of thousands of examinations of workers exposed to a variety of chemicals, and a study, using exactly the same procedure, of laboratory animals exposed to chemicals under controlled conditions. We are not considering results of accidental acute exposures, but of low grade exposures of a type which is extremely frequent in industry and which can lead to chronic abnormality.

The trend of development of abnormal scores can be rather clearly divided into five stages:

Stage 1. The minimal concentration of a chemical sufficient, on absorption into the body, to cause detectable physiological change, can be withstood for a varying period of time without the appearance of symptoms or of significant changes in blood pressure score.

Stage 2. With the blood pressure score normal on the morning of the first day of the work week, there will be an abnormal score on leaving work on the last day of the week, but a week-end of proper rest restores normality.

Stage 3. With a normal score when commencing work on the first day of the week, the score at the end of that day will be abnormal, but proper rest overnight restores the normal morning level.

Stage 4. The rest overnight is inadequate to restore blood pressure score to normal, so that the degree of abnormality gradually increases throughout the week. However, the week-end of proper rest restores normality.

Stage 5. The week-end of rest is no longer sufficient to bring the blood pressure score back to normal.

If, at any point beyond stage 1 the worker is exposed, even for a short time, to higher concentrations of the harmful chemical, there may be a rapid deterioration in his condition. In fact he may respond in a manner out of all proportion to the intensity of this new exposure. His response may be more drastic even than that of a hitherto unexposed worker suddenly subjected to a very much higher concentration of the chemical. This mode of response may be the basis of the so-called 'idiosynerasy' of workers. It is often the source of the "temporary inadequacy" of personnel described above as a cause of accidents. This response is, therefore, of great significance.

It has been pointed out above that the physiological changes leading to abnormal blood pressure scores are not specific for any chemical but may be produced by factors other than chemicals. These include disease, malnutrition, self-medication or improper medication, fatigue, and sudden deprivation of oxygen. It is possible that any one of these factors may force a worker beyond stage 1. As a result he will become sensitive to concentrations of chemicals which usually will not affect him. It is also possible that a worker, forced beyond stage 1 by exposure to industrial chemicals, will suddenly deteriorate because of the action of one or more of these other factors.

At this stage it is important to discuss briefly the "external" factors (i. e., those external to industrial exposure), which act in the same manner as industrial exposure to chemicals.

(Concluded in March issue)

Editorial

DELAWARE STATE MEDICAL JOURNAL

Owned and published by the Medical Society of Delaware, a scientific society, non-profit corporation. Issued about the twentieth of each month under the supervision of the Publication Committee.

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Vol. 15 FEBRUARY, 1943 No. 2

TOMMYROT

We have just returned from Chicago, where, as a member of the Delaware State Board of Medical Examiners, we represented this state at the 39th Annual Congress on Medical Education and Licensure. The program of this important meeting will be found on page 33.

One of the pressing problems on which we sought enlightenment on our arrival, for the *nth* time, in the Windy City (it was a mere 6 below when we got there), was what was to become of our internes after they had spent nine months in our hospitals. Would the Army take them then? Would the Navy? If they wouldn't, what would be the disposition of Group A after Group B arrived? An authoritative official answer to these and kindred questions was not made, except that the Navy *would* take internes of nine months and arrange for the final three months interneship within the service. This was some help, but not enough, since the Army requires several times the number of doctors that the Navy does.

It was the Army primarily that requested the medical schools to streamline their courses so that doctors would be graduated in three instead of four years. The schools agreed, and with considerable extra strain on their personnel and material resources, are doing this job and doing it well! This means that every nine months a new crop of internes is available for the hospitals and hence every nine months a crop of internes will be leaving the hospitals, ready to enter the armed services. Bear in mind that at this point in their careers the Navy *will* accept them. The different attitude of the Army is illustrated by the following letter, replying to a query which we instigated:

WAR DEPARTMENT
Services of Supply
Office of the Surgeon General
Washington

February 13, 1943.

Mr. C. A. Hume,
Superintendent,
The Delaware Hospital,
Fourteenth and Washington Streets,
Wilmington, Delaware.

My Dear Mr. Hume:

The Surgeon General directs that I acknowledge your letter of February 11th, 1943.

We are acutely aware of the difficulty caused by the overlap due to the accelerated medical program insofar as it concerns interneships. This has been a vexing problem with us insofar as it pertains to our individual supporting hospitals, to the Federation of State Boards of Medical Licensure, and to the Procurement and Assignment Service.

We are, however, on recommendation of Mr. James Hamilton of the American Hospital Association and the Council on Medical Education of the American Medical Association, insisting on 12 months interneship. If we once accept an interne at the end of 9 months and put him on active duty status with pay, we fear that it will put the Surgeon General in the light of competing with the hospitals for internes. It is, therefore, our respectful request that such internes be allowed to secure affiliated services for the remaining 3 months if they cannot be handled in the capacity of sub-residents. In this connection, Dean Rappleye of New York or Dr. Buerki of the University of Pennsylvania School of Medicine have tentatively agreed to serve as clearing houses for such services.

Sincerely yours,

DURWARD G. HALL,
Lt. Col., Medical Corps,
Assistant.

From the above, it is the laudable purpose of the Army not to compete with the hospitals for internes. Is the Army competing if they take internes which the hospitals want to get rid of and for whom no housing is available? Is the Army competing if they take internes for whom no salaries or stipends are available? Is the Army competing if they take internes so numerous as to be in each other's way? Tommyrot!

The makeshift of "affiliated services for the remaining 3 months" is yet to be tried. Judging from the tone of his remarks at Chicago we doubt if Dean Rappleye expects it to work very well; we ourselves fear it will turn out to be a mere gesture, in which case the hospitals, every nine months, will have two crops of internes to house, feed, and pay, for the next 3 months, the senior crop being billeted in boarding houses as near the hospital as possible, and rendering a minimum of service to the hospital, meanwhile losing the educational momentum which the internship is intended to provide. This situation sizes up to—more tommyrot.

Since one of the major premises of the streamlined program was that there should be no deterioration in the quantity or quality of medical education, take a good look at the interneship of today. With a shortage of civilian doctors, more and more patients are obliged, in the more serious illnesses, to go to the hospitals, which are now running 100-110% of normal capacity. Before the emergency they were running 75-80% of capacity. Using the lower figures, it is apparent that a nine months service at 100% is exactly equal to a twelve months service at 75%. Certainly, with waiting lists at all our local hospitals, the interne here today gets as much education in nine months as he formerly got in twelve months. This crowding of the hospitals is general throughout the country, hence a blind insistence on twelve months is again—plain tommyrot.

The other angle to this interneship question is that of licensure. The laws of most states specify that the medical curriculum shall extend over four years; some even specify that these four years shall be four different calendar years; some simply say four academic years. Streamlining the course to three years now requires either legislative relief or Attorney-General opinion to the effect that the present law grants sufficient latitude. Further, most laws require an interneship of twelve months, so again relief must be had either by legislation or opinion.

At the December conference of the Executive Committee of the Federation of State Boards and the Directing Committee of the Procurement and Assignment Service a "model bill" was drafted, and sent, as a suggestion, to all the states. This bill has been introduced into the legislatures of some 22 or 23 states, with prospects of prompt enactment. The remaining states are, apparently, straightening out their legal problems on an independent basis.

Further, Delaware and Pennsylvania were the only states that added a new section specifically providing for the nine months interneship, so the Board in this state is all set to go as soon as our bill (S. B. No. 38) passes the House. It has already passed the Senate and the Governor is for it.* Then, should we receive applications from the crop whose nine months interneship is over on March 31st, we will arrange to examine them promptly, probably on April 13-15th. Pennsylvania will do likewise.

But back to our original thesis. Why can't the Army do what the Navy does? Do they have some really good reason, as yet undisclosed, or are they over-influenced by ultra-conservatism? We are in a dire emergency: what is the course to be—expedition and expediency, or tradition and tommyrot?

Delaware Academy of Medicine

Election of February 23, 1943

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* The Governor signed this bill March 4, 1943.

THIRTY-NINTH ANNUAL CONGRESS OF MEDICAL EDUCATION AND LICENSURE

February 15 and 16, 1943
Palmer House, Chicago

Council on Medical Education and Hospitals

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REPORT OF THE COUNCIL ON MEDICAL EDUCATION AND HOSPITALS OF THE AMERICAN MEDICAL ASSOCIATION.

RAY LYMAN WILBUR, M. D., Stanford University, Calif. Chairman of the Council on Medical Education and Hospitals.

*EDUCATION AND THE WAR.

EDWARD C. ELLIOTT, LL. D., Washington, D. C. Chief, Professional and Technical Employment and Training Division, War Manpower Commission.

*PREMEDICAL AND MEDICAL EDUCATION AS RELATED TO THE UNITED STATES ARMY.

BRIGADIER GENERAL JOSEPH N. DALTON, Washington, D. C., Assistant Chief of Staff for Personnel, United States Army.

*MEDICAL EDUCATION AS RELATED TO THE PROCUREMENT AND ASSIGNMENT SERVICE.

HAROLD S. DIEHL, M. D., Minneapolis. Member, Directing Board, Procurement and Assignment Service for Physicians, Dentists and Veterinarians.

GRADUATE EDUCATION AND THE WAR.

DONALD C. BALFOUR, M. D., Rochester, Minn. Director, Mayo Foundation for Medical Education and Research.

*MEDICINE AND THE WAR.

COL. GEORGE F. LULL, M. D., Washington, D. C. Chief, Personnel Division, United States Army Medical Corps. (Representing the Surgeon General of the United States Army.)

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THOMAS PARRAN, M. D., Washington, D. C. The Surgeon General, United States Public Health Service.

MEDICAL LICENSURE AND CIVILIAN MEDICAL NEEDS.

HARVEY B. STONE, M. D., Baltimore. Member, Directing Board, Procurement and Assignment Service for Physicians, Dentists and Veterinarians.

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THOMAS C. ROUTLEY, M. D., Toronto, Ontario. General Secretary, Canadian Medical Association.

Federation of State Medical Boards

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MEDICAL LICENSURE IN NEW YORK STATE.

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MEDICAL SCHOOLS IN WARTIME.

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PRESIDENTIAL ADDRESS.

JULIAN F. DUBOIS, M. D., St. Paul, Secretary, Minnesota State Board of Medical Examiners.

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J. W. HOLLOWAY JR., Chicago, Director, Bureau of Legal Medicine and Legislation, American Medical Association.

* Published in J. A. M. A., Feb. 27, 1943.

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ORIN E. MADISON, Ph. D., Detroit, President, Michigan State Board of Examiners in the Basic Sciences.

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UNIFORM INTERSTATE ENDORSEMENT AS A WAR EMERGENCY MEASURE.

J. EARL MCINTYRE, M. D., Lansing, Mich. Secretary, Michigan Board of Registration in Medicine.

OBITUARY

CHARLES G. HARMONSON, M. D.

Dr. Charles G. Harmonson, of Smyrna, died at his home on February 4, 1943, at the age of 81 years. He had just rounded out 58 years of active practice in the Smyrna-Clayton area.

After his graduation from Jefferson Medical College in 1884, Dr. Harmonson began the practice of medicine in Clayton and had since that time been active in the affairs of both Clayton and Smyrna. He had been a president of the Kent County Medical Association, a charter member of the Smyrna Rotary Club, one of the organizers and former vice-president of the Clayton Bank and Trust Co., former president of the Clayton Savings and Loan Association, and former trustee of the Smyrna Library Association. He was a communicant of St. Peter's Church.

Dr. Harmonson was a member of the Kent County Medical Society, the Medical Society of Delaware, and the American Medical Association.

His first wife, Lola Blackiston Harmonson, died in 1938.

Surviving are his widow, Pauline Start Harmonson; a son, C. Leland Harmonson, of Smyrna; a granddaughter, Mrs. H. Kline Weir, of Pittsburgh, and two great-grandchildren.

Funeral services were held on February 7, 1943, at St. Peter's Episcopal Church, with the Rev. Frederick Marx Barton officiating. Interment was in Glenwood Cemetery, at Smyrna.

BOOK REVIEW

Indigestion: Its Diagnosis and Management. By Martin E. Rehfuss, M. D., Professor of Clinical Medicine, and Sutherland M. Prevost, Lecturer in Therapeutics, Jefferson Medical College. Pp. 556, with 63 illustrations. Cloth. Price $7.00. Philadelphia: W. B. Saunders Company, 1943.

This is a very complete work covering medical and surgical conditions of the G. I. tract. Starting with the chapter on "Taking the History," there are many suggestions and explanations with a most concise method which, if carefully followed, should be invaluable to the general practitioner.

"Physical Diagnosis" is thoroughly covered and is profusely illustrated with charts and diagrams of topographical anatomy and differential diagnosis. The value of the gastroduodenal tube to the general practitioner is explained and many practical suggestions for its use are given.

Xray examination includes much of the teachings from Carman, with numerous drawings showing niches and characteristic deformities of gastric and duodenal ulcers.

Gastroscopy and gastrophotography, showing many films of gastric disease which could not be diagnosed by any other method, is indeed very interesting and modern. Many classes of indigestion are considered, both functional and organic, such as ulcer, malignancy, biliary types, cardiac types, allergy, and the most common of all, nervous indigestion.

There are many charts and tables furnishing valuable information on foods, giving composition, values and vitamins, as well as special diets, with detailed methods of treatment.

In all this is a most remarkable book, which should be accepted enthusiastically by the profession as a whole.